Managing With-Profit Portfolio using a Stochastic Approach

With a Focus on the Asia Market

Submitted for the 20th Asian Actuarial Conference

September 2016

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An EXCEL tool that illustrates the stochastic and dynamic model discussed in the paper can be downloaded at http://swinsolutions.com/download/WP\%20Model.zip.

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Executive Summary

With-Profit (WP) products, also known as Participating (Par) products, have become more and more popular in India and Asia. These products provide customers with the opportunity to share the insurance company’s profit while getting the guaranteed benefits as in traditional insurance products. Insurance companies can also pass through some risks such as investment risk and insurance risk to customers.

At the same time, its flexibility and long-term nature make it difficult for pricing and risk assessment. The business is highly exposed to financial risk, policyholder behavior risk, and regulatory risk.

1. The 2008 financial crisis led to an increasing level of risk awareness which caused the revaluation of the embedded options and guarantees in WP products. Bonus rates were materially reduced in developed market due to both bad investment performance and the higher value of the options and guarantees.

2. An unexpected bonus rate reduction can easily cause undesirable policyholder behaviors such as excessive lapses. In addition, a steady bonus rate with a high new money rate can also cause dynamic lapses as policyholders want to surrender policies to reinvest with a higher return. This makes bonus rate determination a complicated process that requires robust analysis.

3. Regulators around the global have been pushing for more transparency in WP business management. In UK, the FSA requires each firm to publish a document called the Principles and Practices of Financial Management (PPFM) to explain the investment strategy and management process. In India, the IRDA requires every insurance company to set up a WP committee at the board level to control asset allocation, expense allocation, and investment practices of WP funds.

With these challenges in WP business development and management, more advanced analytical methods are needed to help us understand the impact of risks and determine a reasonable price. Stochastic models with dynamic linkages between asset and liabilities provide a more realistic picture of all possible scenarios. Stochastic analysis can help manage WP business in the following area:

1. Product feature designs. Stochastic analysis can estimate the impact of different product features compared to the risk appetite of the company to make sure the risk tolerance will not be exceeded. A fair price appropriate for the level of guaranteed benefits can also be determined.

2. Bonus rate determination. Setting a dynamic bonus rate determination strategy is difficult due to the interaction between asset and liability, dynamic policyholder behaviors and competitive environment. Stochastic analysis can help decision makers understand the possible results of different strategies and find out the optimal balance between profitability and competitiveness.

3. Risk management. Even though WP products transfer part of the risks to customers, implicit guarantees due to competitive consideration and undesirable policyholder behaviors make the risk assessment important. Stochastic models can help estimate the cost of embedded guarantees and its impact on capital adequacy and earnings volatility.

With a well-designed management framework supported by stochastic analysis and strategies, active management actions can turn these challenges into opportunities. This paper illustrates the whole process of stochastic analysis using a simplified numerical example. It is hoped that this paper and accompanying illustration tools can help practitioners understand the models and ready to put them into practices.
1. Introduction

With-profit products or participating products share the profits of an insurance company with policyholders. In addition to the death benefit and maturity benefit provided by traditional life insurance products, a with-profit product also provides policyholders bonus/dividend based on the performance of a with-profit fund.

Bonuses are usually distributed in three ways: cash bonus (CB), reversionary bonus (RB) and terminal bonus (TB). Cash bonuses are distributed to policyholders in the form of cash. Reversionary bonuses are distributed by increasing the sum assured of the policy so that future death benefit, surrender benefit and maturity benefit could be higher. There are also two types of RB: simple RB and compound RB. For simple RB, the amount of bonus is determined as the initial sum assured multiplied by the bonus rate. For compound RB, the amount of bonus is determined as the current sum assured including previous declared bonuses multiplied by the bonus rate. With the same bonus rate, the impact of compounding could lead to a material difference of the amount of bonus. Terminal bonus is normally paid at death or maturity. The remaining surplus belonging to the policy is shared between policyholders and shareholders.

In most cases, the profits are shared between policyholders and shareholders according to a specified rule. For example, the 90/10 rule means that policyholders will take 90% of the profits and shareholders will take the remaining 10%. The sharing rule could be affected by regulators or market competition. In addition, the profits or surplus to be shared varies by product. Some products may only share the investment gains. Some may also share mortality experience and lapse experience. Others may share all the experience gains/losses including expenses.

With-profit products are complicated products with high uncertainty, mainly because of the following:

1. The products are normally long-term products which are exposed to high asset liability mismatch risk. Lower reinvestment returns than the pricing interest rate can cause lower profitability or even losses. However, the risk is difficult to predict. In a competitive market, if other market players are making decisions with a shorter time horizon, a company may still be forced to provide competitive prices even it knows it is lower than required by the long-term risk.

2. The long-term nature of the business leads to the uncertainty of bonus rates. Insurers will need to balance among bonus rate sustainability, policyholder expectation, market competition and profitability. The bonus rate cannot be too volatile so that the product appears to be too risky. It cannot deviate too much from policyholder reasonable expectation to avoid mass lapses. It needs to stay competitive to attract enough business volumes to reach an economic scale. And it also needs to achieve minimum profit requirements in the long-term.

3. The products are subject to high policyholder behavior risk. In an increasing interest rate environment, for an existing WP fund, the investment return is under high pressure. Normally WP funds are largely backed by fixed income securities whose value will decrease in such an environment. At the same time, policyholders are likely to surrender their policies to pursue the high new investment return. Insurers will face a difficult decision: whether to declare a higher bonus rate than actual investment return to keep existing customers or declare a low bonus rate to keep the short-term profit. Some insurers may take a riskier investment strategy for a higher return. An optimal balance needs to be found to reduce the risk.
4. Undistributed estate. A WP fund with a long history may have a significant amount of estate. For example, the fund may accumulate surrender surplus without distributing to remaining policyholders but reserve for future investment performance volatility. On the other hand, undistributed estate means that the shareholder portion remains in the fund and cannot be used to support other risk-taking activities. The estate may also be used to absorb future losses and the value of the shareholder portion could diminish. If other market players aggressively distribute all the surrender surplus to support high bonus rates, it may also keep the company in an uncompetitive position. This is also a difficult decision that needs advanced analysis to support.

Stochastic analysis with dynamic modeling can help find solutions to the difficult issues of WP products. It provides us a holistic view of future possible outcomes including investment performance, policyholder behaviors and management actions. The effectiveness of management strategies can be tested against each scenario. This paper explains how stochastic analysis can help improve WP product management. The remainder of this paper is structured as follows:

- Section 2 (Asia With-Profit Insurance Market) provides an overview of current WP insurance market in Asia and its regulatory environment.
- Section 3 (Stochastic and Dynamic Modeling) discusses a number of approaches for analyzing WP products in a stochastic and dynamic way.
- Section 4 (Applications) discusses how stochastic and dynamic modeling can be used in WP product management.
- Section 5 (Numerical Example) illustrates the stochastic modeling of a WP product.
- Section 6 (Conclusion) summarizes the key points of this paper.

2. Asia With-Profit Insurance Market

Recently the insurance companies in India, especially the private players, have renewed their love for the participating business. This renewed penchant for participating business by Indian insurance players can be attributed to their strong attempt to maintain business growth once unit linked business lost its appeal both for the insurers and for the customers. There were both push (regulatory) and pull (economic) factors that led to this phenomenon. Firstly, the regulatory cap on charges (and hence on commission) reduced the profitability of the once upon a time insurers’ and distributors’ darling: the unit linked business. Second, the stock market crash in 2008 which the customers had not even anticipated destroyed their dreams of making money from their investment. Because of the loss of investor’s interest in the stock market due to unattractive returns and increased market volatility, insurance companies started shifting their focus on less volatile businesses. Conventional Participating business is thus being viewed by the insurer as an appropriate replacement for the unit linked business. Regulations in India do not allow participating business on a unit linked platform. From customer’s perspective it can provide better returns than a plain vanilla traditional non-participating contract and it has the potential to match the returns that are expected from a unit linked contract. Therefore, the 2008 market crash and the stricter regulation of unit linked business that followed led to increasing marketing efforts of participating business. Given the volatility index of stock markets touching new highs, investors in India (primarily risk averse) are unlikely to take up equity investment materially in the near future. If this persists and the market continues developing better understanding of the participating business, the market share of participating business may grow further from here.
However, the development of participating business is faced with challenges as well. Unlike other businesses, the participating business is accompanied with significant level of power imbalance between insurers and their customers at large. Customers rely on the insurer for fund investment and management. It is important that appropriate regulations are in place to protect the interests of customers. The actuarial profession plays a significant role to protect the interest of all the stakeholders including customers, shareholders or regulators. In the “Asia Participating Business Survey” conducted by Milliman in 2013, Responses from senior life insurance executives indicate that there is a large room of improvement regarding WP fund management. 44% of survey participants did not use stochastic models to manage WP business. There was a lack of formalization of policyholder reasonable expectation (PRE) and the management principles and practices were not effectively communicated with policyholders. The situation may be worse for a less developed market like India, even though the participating business is not new to the Indian market. Life Insurance Corporation (LIC) of India is a public sector insurer which has been operational since 1956. Even today, a significant proportion of the participating business is taken by the LIC. However, many life insurance companies in India still do not have a clear and detailed published policy on the Par business management. Looking back into the history, participating business went through similar stages of expansion in UK around 1980s and 1990s when they were being sold heavily riding on the higher interest rates. The low interest rate environment hit UK economy subsequently and some insurance companies went into financial trouble. With the history in mind, Indian and Asian insurers need to get more prepared for a sustained low interest rate environment, a more volatile market, and the cultural impact on policyholder behaviors.

3. Stochastic and Dynamic Modeling

Stochastic modeling for WP products is complicated given the long term time horizon and the dynamic policyholder behaviors and management actions. This section discusses the specific issues in stochastic and dynamic modeling for WP products.

3.1 Stochastic Modeling

In general, there are two types of stochastic modeling, classified by the type of scenarios and the goal of the analysis.

1. Fair valuation using risk neutral scenarios. Fair valuation is to find the market price of the guarantee. If there is a market instrument that is the same or similar to the guarantee, the market price will be used as the cost of the guarantee. However, for insurance products, it is often difficult to find similar market instruments due to the inclusion of insurance risk. Theoretically risk neutral scenarios can help us estimate the market consistent value of the guarantees given the current market conditions and assuming a liquid market for transferring the risk of insurance products. Risk neutral scenarios are calibrated to market prices of financial instruments. They are only helpful for finding the cost of guarantee which is the average value across all scenarios. Because they are not realistic scenarios, they have little value helping us understand all the potential outcomes of the guarantees.

2. Stochastic analysis using real world scenarios. Real world scenarios are used to estimate the expected cost of guarantees and all the potential outcomes. The goal is not to transfer or hedge
the risk but to manage it. It is normally used to determine the amount of reserve and capital to be held to support the exposure to embedded options and guarantees.

For WP products, the cost of guarantee is immaterial given that insurers can adjust the bonus rate unless they offer a high level of guaranteed bonus rate. On the other hand, the mismatch between asset and liability because of the long term nature of the business, dynamic lapses, and management actions have a more significant impact on the business compared to the cost of guarantees. Real world scenarios are needed to understand how these factors will play out in realistic scenarios. Therefore, stochastic analysis using real world scenarios are more important for WP management. Some insurers may use stress interest rate scenario to determine the cost of guarantee. Others may use closed form interest rate derivative valuation method. This could be seen as a simplified version of stochastic analysis as long as the future bonus rates are adjustable according to the stress scenarios.

In stochastic analysis, it is important to differentiate the actual investment return and expected investment return. Depending on the asset classes invested in the WP fund, real world stochastic scenarios may include interest rates (Government bond yield curve or swap rate curve), credit spread and default, equity return, real estate return, etc. For example, a 50-year scenario has one yield curve for each year. For each future year, the yield curve determines the future expected return at that point which is used for reserving and bonus rate determination. However, yield curves in future are not observable at that time and shall not be used in the decision-making. On the other hand, actual investment returns realized in the future are determined by future yield curves and asset allocation strategies.

3.2 Dynamic Policyholder Behaviors

The flexible benefit amount caused by uncertain bonus rate could cause dynamic policyholder behaviors including lapses and new business volumes. For example, a lower declared bonus rate than expected is likely to lead to more lapses and less new sales in the future. Dynamic policyholder behaviors are affected by the following key factors:

1. Actual investment return. Investment return affects the bonus rate. High investment return tends to decrease the lapse rate and increase the new sales. Low investment return tends to increase the lapse rate and decrease the new sales.
2. New investment return. When new investment return is higher than the actual investment return, existing policyholders may be attracted by new investment opportunities so they may surrender their policies and reinvest. In addition, new customers may want to invest in newly set up WP fund where the near term investment return is likely to be higher.
3. Bonus rate. Bonus rate is correlated with investment return but some bonus setting strategies may smooth the investment return to declare bonus rate. For policyholders, what really matters are the bonus rates. Treatment of surrender surplus and other undistributed estate could also make a difference in bonus rate setting and therefore lapses and new sales.
4. Surrender penalty. Cash surrender value (CSV) also affects the magnitude of dynamic policyholder behaviors. Higher surrender penalty, or lower CSV will cause less dynamic lapses in the event of high new money rate and low investment return. Surrender penalty will affect static lapse rate as well.
5. Policyholder expectation management. Effective communication with policyholders on how the product works during different economic scenarios can help reduce the dynamic lapses.
Policyholders who lapse for higher reinvestment return may end up getting a lower long term average return due to surrender penalty and the reduction of future interest rates. Some irrational behaviors could be avoided by educating customers and managing their expectation. The effectiveness of expectation management has an impact on dynamic lapses as well.

These factors need to be considered when modeling dynamic policyholder behaviors. Kim (2005) summarized common dynamic lapse models used by insurance companies. They can be easily adapted by including relevant factors for WP products.

### 3.3 Dynamic Bonus Strategies

Bonus setting strategies are important for the success of a WP fund. It has impacts on profits, lapses, new sales, and investment strategies. A good bonus setting strategy need to consider the following factors:

1. **Profit sharing rules.** The portion distributed to shareholders determines the profits that the company can get from selling WP products. At the same time, taking too much from the fund may discourage existing policyholders and future customers and little sales. In addition, regulators may require that certain components above the pricing assumption cannot shared with policyholders but borne by the shareholder fund. For example, expense overrun may not be absorbed by the policyholder fund. The nominal profit sharing ratio could be very different from actual profit sharing ratio. For example, the 90/10 rule could become 91/9 rule in reality due to expense overrun. This could be true especially in the early stage of a par fund with higher acquisition expenses than expected. A different profit sharing rule could be used in the early stage of a par fund to reflect the impact of potential expense overrun. This can be put into the stochastic models by adjusting the profit sharing ratio according to the age of the WP fund.

2. **The split between cash bonus, reversionary bonus and terminal bonus.** Cash bonus and reversionary bonus are preferred by the policyholders as the benefit is received immediately while terminal bonus is more uncertain and may not be able to collect if the policy is surrendered before maturity. To obtain a competitive position, other market players may aggressively offer high cash bonus and reversionary bonus while limiting terminal bonus. Therefore, cash bonus and reversionary bonus take the majority of the asset share. The terminal bonus rate is usually determined by two approaches. The insurer may adjust the reversionary bonus and the terminal bonus by the same percentage to avoid more complexity of bonus rate setting. Or if the insurer manages to track the asset share at the policy level, terminal bonus is the remaining asset share of that policy at maturity.

3. **The stability of bonus rates.** Policyholders may prefer stable bonus rates during the life of the policy. A zero bonus rate followed by a bonus rate of 8% could be considered much worse than a bonus rate of 3% followed by 5%. A series of gradual changes in bonus rate is more acceptable than a sudden change. A maximum annual change of the bonus rate may be applied to smooth volatile investment returns.

4. **Undistributed estate.** Estate including surrender surplus, a.k.a. surrender profit, can be used to support higher bonus rate for remaining policies or prepare for future unexpected losses. The management of free estate needs to consider the generational equity among policies and also the
competitiveness of bonus rates. Normally it is not expected that free estate will be used in one
time but gradually over a medium or long term to maintain a certain level of equity among
different generations of policies. On the other hand, free estate may be used to boost the
competitiveness of an WP product in the short term. It may be caused by investment experience
below the expected level, or a new market player who can credit higher new money rate than
existing portfolio rate. Using free estate can increase the persistency of the portfolio which is
likely to benefit the policyholders in the long term.

5. Trigger of bonus rate changes. Normally target bonus rates are set so that they are sustainable
and will distribute all the profits in a consistent way assuming all the pricing assumptions are
realized. However, given the market volatility, deviation from the pricing assumptions often
occurs. Bonus rates will be reset if the deviation exceeds the pre-specified trigger point. For
example, some companies use the ratio of asset share and gross premium reserve to estimate the
magnitude of deviation. If the ratio exceeds 110%, for example, the bonus rate will be increased.
If the ratio is less than 90%, for example, the bonus rate will be decreased. For any value between
90% and 110%, the bonus rate will remain unchanged. However, for a new WP fund, gross
premium reserve is likely to be very small in the initial period, which makes the ratio high. But
that is not caused by changes in economic conditions. Therefore, this method is not
recommended for new WP funds. Another method is to estimate the bonus rates that will
distribute the entire asset share at the maturity of the portfolio. It is a consistent method across
time as a zero final surplus is the target.

6. Competitive position. WP products are subject to a competitive environment in a high and
increasing interest rate environment. This is a likely scenario for India market as the economy is
developing at a fast speed. New WP funds could be established to attract business from funds
with a longer history whose investment performance is under pressure due to increased bond
yields. The company may choose to subsidize the bonus rate so that mass lapses can be avoided
and new sales can come in to drag up the portfolio return. It may also set up new WP funds that
provide higher bonus rates than existing WP funds.

A balance of these considerations needs to be found in practice according to the company’s business
development plan and risk appetite.

4. Applications

Stochastic and dynamic models can be used to predict future uncertainty and the interaction among
insurers, policyholders, insurance market and the capital market. It can help insurers make informed
decisions on product development, business strategy and risk assessment. Some of the application are
illustrated in Section 5.

4.1 Product Development

Stochastic and dynamic models can help quantify the risk of WP products. They are useful for:

1. Selecting appropriate product features such as the bonus type and minimum bonus rate
guarantee. The impacts of RB and TB are quite different. RB has an immediate impact on the
liability while TB has much less near-term impact and minimal impact on dynamic lapses. Simple bonus rate and compound bonus rate also make a significant difference. Stochastic and dynamic models can be used to estimate the result of using a certain bonus type. In most cases, the theoretical minimum bonus rate is 0%. Some companies may provide a positive guarantee that is slightly higher than 0%. However, when selling the products, two or three illustration scenarios are normally used with the lowest one perceived by policyholders as the soft guarantee the insurance company promises. Any return below the soft guarantee could significantly disappoint policyholders and cause reputational risk. However, the actual soft guarantee may be lower than, if not by much, the lowest illustration rate. When the company is in a financial distress, the minimum illustrate rate may still be maintained. But when the company is in a financial disaster, it may consider reducing the bonus rate below the minimum illustration rate as the limited financial resources need to be allocated to meet other more important regulatory requirements. Insurers may also be forced to have an effective yet contractual guarantee because of market competition. Stochastic models can be used to estimate the cost and impact of different guarantee levels for decision-making, either contractual guarantee, soft guarantee, or minimum illustration rate.

2. Setting reasonable premium rates. By taking full account of future risks, stochastic models can be used to determine the appropriate premium rates that are consistent with the company’s risk appetite. Even though market conditions may lead to lower premium rates to be competitive, model implied premium rates can still be used as a benchmark in pricing.

3. Designing customer communication plans to set reasonable expectation. Stochastic modeling can also help estimate the magnitude and impact of dynamic policyholder behaviors. The price is set based on these assumptions. Effective communication to potential customers on the risk of the product is necessary for realizing the assumptions. Some stochastic scenarios may also be used for illustrating the volatility of bonus rates.

### 4.2 Business Strategies

Business strategies that consider future changes in economic environment and policyholder behaviors are likely to help insurers survive the difficult times and earn long-term gains.

1. **Bonus rate setting strategy.** Different bonus strategies and their parameters, such as those discussed in Section 3.3, can be tested using stochastic models to assess their impact.

2. **Profit sharing strategy.** Stochastic models can also be used to test the impact of profit sharing strategies including the profit sharing rules and how and when surrender surplus will be distributed to remaining policyholders.

3. **Policyholder behavior management strategy.** This is intertwined with bonus rate setting strategy and profit sharing strategy. To reduce dynamic lapses, the company may adjust bonus rate and profit sharing. The effectiveness of the strategy and the impact on profit can be evaluated using stochastic models as well.

4. **Capital allocation among business lines.** Stochastic and dynamic models can help understand the possible scenarios of risk adjusted return on capital (RAROC) for the WP portfolio compared to the return on other business lines. Business line with higher RAROC and lower correlation with other
business lines (higher diversification benefit) needs more capital for development to gain a higher expected return for investors.

4.3 Risk Assessment

WP products may cause unexpected adverse outcome that significantly reduce insurers’ earnings and available capital. With stochastic and dynamic modeling, more advanced risk assessment can be conducted.

1. Economic capital. Economic capital measures the required capital to meet a target confidence level of being economically solvent. Stochastic models are required to estimate the loss distribution so that the required capital can be determined based on the chosen probability. The result can be used to test capital adequacy and to allocate capital across business unit and product line in a consistent way.

2. Cost of guarantee. Stochastic models can also be used to estimate the cost of guarantee provided in the WP product. Risk neutral scenarios can be used to estimate the fair value of the embedded options which are useful for hedging. Real world scenarios can be used to estimate the range of cost if the risk is retained and managed in house.

3. Risk adjusted measures. With more complete analysis of the risk by stochastic models, risk adjusted measures can be used to help decision-makers to understand the return and risk tradeoff for a WP product. For example, return on risk adjusted capital (RORAC) measures the future profits as a percentage of future required economic capital which measures the risk of the product. Value measures such as the market consistent embedded value (MCEV) take into account the cost of risk capitals when determine the value of the business.

5. Numerical Example

A typical With-Profit product is analyzed using the stochastic and dynamic approach. This numerical example focuses on the key challenges that are present in with-profit product management and modeling. Dynamic bonus rate setting, dynamic policyholder behavior, cost of guarantees and risk based capital measurement are explained in details.

5.1 Product

Insurance company ABC plans to sell a with-profit product but is concerned about the risks that may emerge. The company wants to examine all the potential risks and possible risk mitigations. The with-profit product offers basic death benefits, surrender benefits and maturity benefits. In addition, it also provides reversionary bonus and terminal bonus based on the performance of the fund.

5.2 Economic Assumptions

The company adopts the stochastic approach for the analysis. Stochastic scenarios including government bond yields, A-rated corporate bond credit spread, equity return and real estate return are generated using the following assumptions.
Table 1. Economic Assumptions

<table>
<thead>
<tr>
<th>Economic Variables</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Government Bond Yields</td>
<td>The yield curve at November 2015 is used.</td>
</tr>
<tr>
<td></td>
<td>Term</td>
</tr>
<tr>
<td></td>
<td>Yield (%)</td>
</tr>
<tr>
<td>Bond Yield Volatility</td>
<td>Historical 10-year government bond yields are used as a calibration target for the stochastic interest rate model. Monthly data from May 1998 to November 2015 is used to estimate the volatility which is 1.76%.</td>
</tr>
<tr>
<td>Credit Spread</td>
<td>The following credit spread (CS) assumption is used for A-rated corporate bond.</td>
</tr>
<tr>
<td></td>
<td>Term</td>
</tr>
<tr>
<td></td>
<td>CS (%)</td>
</tr>
<tr>
<td>Credit Spread Volatility</td>
<td>A volatility of 1.17% is used in the example.</td>
</tr>
<tr>
<td>Equity Return</td>
<td>The total equity return is modeled as the sum of the short rate (1-year government bond yield in this example) and the risk premium. The risk premium was about 6.13%, based on the experience data from October 1998 to October 2011. However, a 4% risk premium is used considering that 4% is more sustainable in the long term with the development of India economy.</td>
</tr>
<tr>
<td>Equity Return Volatility</td>
<td>A volatility of 25% is used based on the average stock index volatility from 1995 to 2013.</td>
</tr>
<tr>
<td>Real Estate Return</td>
<td>An annual return of 20% at initial decreasing to 10% in 100 years is assumed.</td>
</tr>
<tr>
<td>Real Estate Volatility</td>
<td>25%</td>
</tr>
<tr>
<td>Correlation Matrix</td>
<td>Correlation is estimated using either experience in 2011 and 2012 or expert judgement in this example.</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>Credit Spread</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>1.00</td>
</tr>
<tr>
<td>Credit Spread</td>
<td>-0.20</td>
</tr>
<tr>
<td>Equity</td>
<td>0.08</td>
</tr>
<tr>
<td>Real Estate</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Shang et al (2013) built an economic scenario generation (ESG) tool for pension plan embedded option valuation. The tool has been used for scenario generation in the example with small adjustments. The details of the ESG are not covered here. With the economic assumptions, the following models are used.

3 Revised ESG tool can be downloaded at [http://www.swinsolutions.com/download](http://www.swinsolutions.com/download).
to generate the stochastic scenarios.

**Initial Yield Curve Extension**

The initial yields need to be interpolated and extrapolation so get a complete yield curve with rates at each annual term.

**Cubic spline method**\(^4\) is used for interpolation in the example to allow perfect match with market data and ensures the continuity and smoothness of the yield curve. Other methods such as linear interpolation can also be used in practice.

**Nelson-Siegel method**\(^5\) is used for extrapolation. It assumes that the yield curve is affected by three factors: short-term, medium term and long-term factors. The long-term factor is the sustainable interest rate in a normal pace of development. The impact of short-term factor and medium-term factor will phase out gradually.

\[
r_m = \beta_0 + \beta_1 \left(1 - e^{-\frac{m}{\tau_1}}\right) + \beta_2 \left(1 - e^{-\frac{m}{\tau_2}} - e^{-\frac{m}{\tau_1}}\right)
\]

Where

- \(\beta_0\): The long-term spot rate.
- \(\beta_1\): The short-term contribution component.
- \(\beta_2\): The medium-term contribution component.
- \(\tau_1\): The volatility decay factor for short term.
- \(\tau_2\): The volatility decay factor for medium term.
- \(r_m\): The spot rate with a term of \(m\).

The fitted model using India government bond yields in Nov. 2015 is given below.

Other methods such as constant spot rate/forward rate method can be used for extrapolation. However, considering the fast development of current India economy, current high yield may not be sustainable after 30 years, for example.

Using November 2015 government bond yields, the extended yield curves using different interpolation and extrapolation methods are illustrated below.

**Figure 1.** Extended India Government Bond Yield Curve (Nov. 2015)

\(^4\) Details of the cubic spline method can be found on pages 13, 54-55 of Shang et al (2013).

\(^5\) Details of the Nelson-Siegel method can be found on pages 14-16 of Shang et al (2013).
Interest Rate Model

The one-factor Hull-White model⁶ is used to generate interest rate scenarios.

\[ dr = (\theta(t) - \alpha r)dt + \sigma dz \]

The mean of the short rate \( r \) reverts to \( \theta(t)/\alpha \) at rate \( \alpha \).

Model parameters (\( \alpha = 0.06 \) and \( \theta = 0.0075 \)) are calibrated so that the volatility of 10-year government bond yield is close to the historical average value which is 1.76%.

Credit Spread Model

The one-factor Hull White model is also used to model A-rated corporate bond credit spread for illustration purpose. In practice, other sophisticated models as the L can be used to model the credit spread at all levels of credit rating.

Model parameters (\( \alpha = 0.06 \) and \( \theta = 0.005 \)) are calibrated so that the volatility of the credit spread is expected to be 1.17%.

Equity Return Model

The total equity return is the sum of interest rate generated by the one-factor Hull White model and the excess equity return generated by the lognormal model (\( \mu = 0.4, \sigma = 25\% \)).

\[ \log \frac{\text{Excess Return Index}_{t}}{\text{Excess Return Index}_{0}} \sim N\left(\mu - \frac{1}{2} \sigma^2 t, \sigma \sqrt{t}\right) \]

Real Estate Return Model

The real estate is modeled using lognormal model with parameter \( \sigma = 20\% \) at initial and then

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⁶ Details of one-factor Hull White model can be found on pages 55-57 of Shang et al (2013).
gradually decreasing to 10% in 100 years, and parameter $\sigma = 25\%$.

$$\log \frac{\text{Real Estate Index}_t}{\text{Real Estate Index}_0} \sim N\left(\frac{\mu - \frac{1}{2} \sigma^2 t}{\sigma \sqrt{t}}\right)$$

**Correlation**

The correlation assumptions of economic variables need to be preserved in the scenarios. The Cholesky decomposition method\(^7\) is be used to decompose the matrix to facilitate the generation of correlated random variables.

**Investment Return**

Two sets of investment return are calculated for each scenario based on a simple asset allocation plan.

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Government Bond</th>
<th>Corporate Bond</th>
<th>Equity</th>
<th>Real Estate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation</td>
<td>50%</td>
<td>30%</td>
<td>15%</td>
<td>5%</td>
</tr>
</tbody>
</table>

It is assumed that the portfolio will be rebalanced annually. For fixed income securities including government bonds and corporate bonds, the company want to maintain a constant duration of 10 years.

Based on this simple rule, the realized investment return is calculated for each period under each scenario. In addition, new money rate is projected based on the then-current economic scenario. For example, at the beginning of a period, the 10-year spot rate is 7.4\% and the credit spread is 1.67\%. A 10-year zero coupon government bond price is 477 per thousand face amount and a 10-year zero coupon corporate bond price is 404 per thousand face amount. At the end of the period, the 9-year spot rate is 7.89\% and the credit spread is 2.17\%. The government bond price changes to 491 and the corporate bond price changes to 404. Therefore, the realized investment return for government bond investment is $491/477 - 1 = 3\%$. The realized investment return for corporate bond investment is close to zero due to minimal change of the bond price during the period. During that period, the equity return is -4.9\% and the real estate return is 14.8\%. On the other hand, the new money rate, or the policyholder expected return is determined by the new or expected return of each asset class, without considering the volatility embedded in the realized return. At the end of the period, the expected return for government bond is 7.7\% based on the yield curve at that time. It is the one-year yield that the investor can get for a new investment. By adding the credit spread of 2.17\%, the expected return of corporate bond is 9.9\%. The expected equity return is 11.7\%, as the sum of the government bond yield and a risk premium of 4\%. The expected real estate return is 20\%. The aggregated realized investment return and new money rate can be calculated as weighted average of returns of each asset classes with the weights based on the asset allocation.

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Realized Return</th>
<th>New Money Rate</th>
<th>Asset Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Bond</td>
<td>3%</td>
<td>7.7%</td>
<td>50%</td>
</tr>
<tr>
<td>Corporate Bond</td>
<td>0.2%</td>
<td>9.9%</td>
<td>30%</td>
</tr>
<tr>
<td>Equity</td>
<td>-4.9%</td>
<td>11.7%</td>
<td>15%</td>
</tr>
<tr>
<td>Real Estate</td>
<td>14.8%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>Aggregate</td>
<td>1.6%</td>
<td>9.6%</td>
<td></td>
</tr>
</tbody>
</table>

The investment return is used for calculating investment income and discounting. The new money rate is

---

\(^7\) Details of the Cholesky decomposition method can be found on page 18 of Shang et al (2013).
compared to the investment return to measure dynamic policyholder behaviors. In reality, more complicated rules of portfolio rebalancing, reinvestment, duration and convexity matching, and order of asset sales need to be considered.

5.3 Insurance Assumptions

The following insurance assumptions are used in this example.

**Mortality**

The ultimate mortality rate in the Indian Assured Lives Mortality table (2006-2008) is used for insured male. The female mortality is using the same mortality table with a 2-year age set back. Female at age 0 or 1 is assumed to have the same mortality as male at age 0.

**Lapse**

The lapse rate is composed of base lapse rate and dynamic lapse rate. Base lapse rate is the expected lapse rate if the actual investment return has little deviation from the reinvestment return, or the new money rate. Basic lapse rate assumption is normally derived from a company’s experience data with necessary adjustment to reflect different product features. The following basic lapse rate by policy year is assumed in this example.

<table>
<thead>
<tr>
<th>Policy Year</th>
<th>Lapse Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4.5</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>3.5</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>2.9</td>
</tr>
<tr>
<td>10</td>
<td>2.8</td>
</tr>
<tr>
<td>11</td>
<td>2.7</td>
</tr>
<tr>
<td>12</td>
<td>2.6</td>
</tr>
<tr>
<td>13</td>
<td>2.5</td>
</tr>
<tr>
<td>14</td>
<td>2.4</td>
</tr>
<tr>
<td>15</td>
<td>2.3</td>
</tr>
<tr>
<td>16</td>
<td>2.2</td>
</tr>
<tr>
<td>17</td>
<td>2.1</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>20 &amp; +</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Dynamic lapse emerges when the realized investment return and therefore bonus rate deviates from policyholders’ reasonable expectation. An adverse scenario is that a company is holding long term bonds to back liability. Then the interest rate goes up which cause a depreciation of the bond portfolio. The bonus rate will decrease accordingly. At the same time, the policyholders are attracted by the higher new money rate and may surrender the policy to reinvest in a new product.

The following dynamic lapse (DL) is assumed.

\[
DL_t = \begin{cases} 
-\min \left( a \times (r_n - r_p)_t^b, BL_t, d \right) \\
\min \left( \max \left( a \times (r_n - r_p)_t^b - c, 0 \right), d \right)
\end{cases}
\]

Where

- \( DL_t \): Dynamic lapse during period \( t \) in terms of percentage.
- \( r_n \): New money rate in terms of percentage.
- \( r_p \): Portfolio rate which is the realized investment return in terms of percentage.
- \( BL_t \): Base lapse rate during period \( t \).
- \( a \): scale factor.
- \( b \): sensitivity factor.
- \( c \): deductible.
- \( d \): maximum dynamic lapse rate.
\( r_n \) and \( r_p \) are calculated based on the generated scenarios. Parameters \( a, b, c \) and \( d \) can be calibrated to historical data. In this example, \( a = 2, b =2, c=1, \) and \( d = 20. \) With a base lapse rate of 10%, the following graph shows the dynamic lapse rate given the difference between new money rate and portfolio rate.

**Figure 2. Dynamic Lapse Function**

<table>
<thead>
<tr>
<th>Expense</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition fixed expense</td>
<td>85</td>
</tr>
<tr>
<td>Acquisition per premium</td>
<td>17%</td>
</tr>
<tr>
<td>Renewal fixed expense</td>
<td>10</td>
</tr>
<tr>
<td>Renewal per premium</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Commission**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Per Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30%</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>5%</td>
</tr>
<tr>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>6</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Cash Surrender Value**

Cash surrender value (CSV) is calculated as the present value of future benefits deducted by the present value of future premiums, expenses and commissions. Best estimate insurance assumptions including mortality and lapse are used to predict the survivorship. Dynamic lapse is not assumed in the best estimate scenario. Target reversionary bonus rates and terminal bonus rates are used to predict the benefit amounts. A discount rate of 7% is used for conservatism. Compared to the 8.3% expected investment return of given the asset allocation plan, the discount rate provides a competitive advantage.
but also lead to higher expected lapse rate. The calculated CSVs are floored by the regulatory minimum CSV requirements.

**Reserving**

The reserve is calculated using the gross premium valuation, as used in CSV calculation. However, margin for adverse deviation (MAD) is applied to both economic and insurance assumptions. Dynamic lapse is also assumed in reserve calculation. The following MAD is used in reserve calculation.

<table>
<thead>
<tr>
<th>Interest Rate</th>
<th>-10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>10%</td>
</tr>
<tr>
<td>Lapse</td>
<td>-20%</td>
</tr>
<tr>
<td>Expense</td>
<td>10%</td>
</tr>
<tr>
<td>Minimum RB Rate</td>
<td>0%</td>
</tr>
</tbody>
</table>

Unlike the CSV, the company determines the reserve at the valuation date based on the then-current situation. Therefore, the reserve is dynamically calculated given the economic assumptions changing by time. In each scenario, the yield curve changes yearly. Therefore, at each future point, the reserve will be calculated based on the yield curve at that time dynamically. In addition, the reserve is floored by the cash surrender value.

**Asset Share**

Asset share is calculated as follows.

\[
(1 - q_t - w_t)AS_t = (1 + i_t)(AS_{t-1} + P_t - E_t) - (1 + i_t)^0.5(q_t \cdot DB_t + w_t \cdot SB_t) - (1 - q_t - w_t) \cdot SurvB_t
\]

Where

- \(AS_t\): Asset share at time \(t\).
- \(P_t\): Premium income at time \(t\).
- \(E_t\): Expense and commission at time \(t\).
- \(DB_t\): Death benefit during period \(t\).
- \(SB_t\): Surrender benefit during period \(t\).
- \(SurvB_t\): Survival benefit during period \(t\).
- \(q_t\): Mortality rate during period \(t\).
- \(w_t\): Lapse rate during period \(t\).
- \(i_t\): Realized investment return during period \(t\).

In this example, surrender surplus is not separated from the asset share but included when determining future bonus rates.

**Cost of Guarantee**

The only flexible benefits in this product are the reversionary bonus and terminal bonus paid with death or maturity. The contractual guarantee provided in the product is that the bonus will never be negative. In practice, because of policyholder reasonable expectation set up during the sales and market competition, the company may need to offer a soft guarantee on reversionary bonus rate to avoid mass lapses and reputational risk. For example, when selling the product, the insurer may offer two illustration
scenarios: 4% reversionary bonus rate and 8% reversionary bonus rate. The soft guarantee rate could be 3% considering both the level of the lowest illustration rate, the chance of significant financial distress and the avoidance of mass lapse due to unsatisfactory customers. In this example, it is assumed that the company will not hedge the risk but manage it in the long term. Stochastic valuation with real world scenario is used to help determine the potential adverse impact of the guarantees.

**Risk Based Capital**

The current solvency requirement is calculated as 3% Reserve + 0.3% Net Amount at Risk. It may be a good measure for the entire industry but is able to fully taken into account specific product features. Using risk based capital that considers the details of the product can help improve the assessment of capital requirement. Factor based approach such as the U.S. Risk Based Capital (RBC) framework or model based approach such as the economic capital framework can be used.

In this example, economic risk, insurance risk and operational risk are considered for determining the required capital.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Risk</td>
<td>99.5th percentile of the liability value – average value of liability.</td>
</tr>
<tr>
<td></td>
<td>It can be calculated based on the stochastic results using real world scenarios. The confidence level of 99.5% is chosen to be consistent with the company’s risk appetite.</td>
</tr>
<tr>
<td>Insurance Risk</td>
<td>Stress testing. The required capital is measured using the liability value under the stress scenarios deducted by the liability using the best estimate scenario.</td>
</tr>
<tr>
<td></td>
<td>Mortality shock: 10%</td>
</tr>
<tr>
<td></td>
<td>Lapse shock: 20%</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>20% of the required capital for other risks</td>
</tr>
<tr>
<td>Correlation</td>
<td>The dependence of economic variables is included in the stochastic scenarios. The following correlation matrix is used.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Economic Risk</th>
<th>Mortality Risk</th>
<th>Lapse Risk</th>
<th>Operational Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Risk</td>
<td>1</td>
<td>0.3</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Mortality Risk</td>
<td>0.3</td>
<td>1</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Lapse Risk</td>
<td>0.4</td>
<td>0.2</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>1</td>
</tr>
</tbody>
</table>

In practice, the correlation coefficients can be determined based on experience data, industry studies, and regulatory requirements. More advanced approaches such as Copula can be used to model dependence as well.
5.4 Dividend Setting Strategy

The company follows the 90/10 profit sharing rule in general. It aims to distribute all the estate at the maturity of the liability. Considering that it is a new WP portfolio, 91/9 profit sharing rule applies in the first five years to consider the high chance of expense overrun. On an annual basis, reversionary bonus rate is calculated based on the economic assumption at that time so that the ending surplus is zero. However, there are other constraints on the annual rate adjustment. The reversionary bonus rate cannot be changed by more than 25% from previous year to avoid surprises that may cause unexpected policyholder behaviors. It also brings in a smoothing factor in the dividend setting. The company also set a minimum reversionary bonus rate of 3%. It is not contractual obligation but is a soft guarantee because of policyholder reasonable expectation and market competition. The terminal bonus rate is set to distribute the remaining asset share for policies that is terminated due to death or maturity. When calculating the reversionary bonus rate, the terminal bonus rate will change with the same percentage scale. Other approaches such as matching the asset share with the gross premium reserve may be used in practice. However, in many cases especially new business block, asset share and gross premium reserve deviate by much during the initial periods and therefore is not recommended.

Figure 3 shows two extreme examples of the dynamic dividend scales: “High” and “Low”. The “High” bonus scale occurs with some periods of high realized investment returns. The investment return is 19%, 17% and 25% during the 4th, 8th and 13th year, respectively. Because of the 25% maximum annual change of bonus rate, positive surplus remains after the high growth period and leads to increasing bonus rate during the low and even negative returns. In addition, the average new money rate is 12% compared to the average realized investment return which is 9.4% in the “High” scenario. This will lead to positive dynamic lapses that can cause significant surrender surplus. Therefore, the bonus scale keeps increasing.

In the “Low” scenario, the average investment return is 10.7% compared to 9.2% in the base case. However, the average new money rate in the “Low” scenario is only 6.9% which causes a material reduction in dynamic lapses. Therefore, much less surrender surplus is available. Surrender surplus is the key driver of increasing dividend scales in most scenarios in this example.

**Figure 3. Example Bonus Scale and Realized Investment Return**
Both the “High” scenario and the “Low” scenario has the similar level of investment return but significantly different levels of bonus scale. The key reasons are the volatility of the returns, the timing of high returns and low returns, and the new money rates which drive the dynamic lapses. It also demonstrates the importance of using sophisticated stochastic analysis to fully understand the possible outcomes.

5.5 Profit and Risk Measurement

To get a broad view of the profitability and risk from different perspectives, a variety of measures are used.

| Profit Margin (PM) | \( \text{Present Value (PV) of Profit/ PV of Premium} \)  
Where Profit = Net Cash Flow – \( \Delta \) Reserve. |
|-------------------|--------------------------------------------------------------------------------------------------|
| Transfer Margin (TM) | PV of Transfer to Shareholder Fund/ PV Premium  
The transfer is based on the 90/10 profit sharing rule. |
| Internal Rate of Return (IRR) | The return that makes the PV of Distributable Earnings (DE) equal to zero. DE = Profit - \( \Delta \) Capital. |
| Risk Based Capital | Risk based capital as described in Section 5.4. |
| Return on Risk Adjusted Capital (RORAC) | PV of Profit/ PV of Risk Based Capital. The Risk Based Capital is projected using sum assured as the risk driver. |
| Traditional Embedded Value (TEV) | PV of Profit – PV of Cost of Capital |
| Market Consistent Embedded Value (MCEV) | PV of Profit – Cost of Guarantee – FrCoC\(^1\) – CRNHR\(^2\) |

Notes:
1. FrCoC: frictional cost of capital. It reflects the taxation and investment costs on the assets backing required capital\(^8\).
2. CRNHR: cost of residual nonhedgeable risks. It includes the impact of nonhedgeable, nonfinancial risks and nonhedgeable financial risks and should be presented as an equivalent average cost of capital charge\(^9\).

5.6 Calculation Process

Figure 4 shows the calculation process of the stochastic analysis.

---

5.7 Sample Result

For simple illustration, it is assumed that the liability portfolio includes only new policies issued to male at age 40. The premium rate is $40.6 per thousand face amount. The target reversionary bonus rate is 4% and the target terminal bonus rate is 10%. The result is presented per 10,000 basic sum assured. Table 2 lists the statistics of some profit measures.

Table 2. Sample Result: Deterministic vs. Stochastic

<table>
<thead>
<tr>
<th></th>
<th>Liability Value 2</th>
<th>CoG 3</th>
<th>PM</th>
<th>TM</th>
<th>IRR 4</th>
<th>TEV 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic 1</td>
<td>442.1</td>
<td>0.0</td>
<td>20.5%</td>
<td>12.4%</td>
<td>5.2%</td>
<td>332.2</td>
</tr>
<tr>
<td>Average</td>
<td>649.7</td>
<td>0.9</td>
<td>12.9%</td>
<td>6.3%</td>
<td>7.6%</td>
<td>170.9</td>
</tr>
<tr>
<td>Minimum</td>
<td>-174.2</td>
<td>0.0</td>
<td>7.3%</td>
<td>3.7%</td>
<td>4.6%</td>
<td>79.4</td>
</tr>
<tr>
<td>Maximum</td>
<td>6,069.8</td>
<td>5.0</td>
<td>19.8%</td>
<td>9.6%</td>
<td>11.0%</td>
<td>333.8</td>
</tr>
<tr>
<td>0.5% VaR</td>
<td>-98.7</td>
<td>0.0</td>
<td>8.2%</td>
<td>4.2%</td>
<td>5.5%</td>
<td>91.6</td>
</tr>
<tr>
<td>1% VaR</td>
<td>-78.3</td>
<td>0.0</td>
<td>8.9%</td>
<td>4.5%</td>
<td>5.6%</td>
<td>95.7</td>
</tr>
<tr>
<td>5% VaR</td>
<td>36.9</td>
<td>0.0</td>
<td>9.8%</td>
<td>4.9%</td>
<td>6.1%</td>
<td>115.3</td>
</tr>
<tr>
<td>95% VaR</td>
<td>1,675.5</td>
<td>4.2</td>
<td>16.5%</td>
<td>8.0%</td>
<td>9.1%</td>
<td>242.9</td>
</tr>
<tr>
<td>99% VaR</td>
<td>2,786.6</td>
<td>4.9</td>
<td>18.1%</td>
<td>8.8%</td>
<td>9.7%</td>
<td>278.7</td>
</tr>
<tr>
<td>99.5% VaR</td>
<td>3,040.3</td>
<td>4.9</td>
<td>18.8%</td>
<td>9.0%</td>
<td>9.9%</td>
<td>282.0</td>
</tr>
<tr>
<td>Mortality Shock 6</td>
<td>478.1</td>
<td>37.0</td>
<td>18.9%</td>
<td>10.8%</td>
<td>5.5%</td>
<td>295.1</td>
</tr>
<tr>
<td>Lapse Shock</td>
<td>577.1</td>
<td>58.8</td>
<td>19.9%</td>
<td>11.4%</td>
<td>5.5%</td>
<td>323.0</td>
</tr>
</tbody>
</table>

Notes:
1. Deterministic: This is the result in the best estimate scenario. Other results are based on either stochastic analysis or stress testing.
2. Liability Value: The present value of net cash flows excluding investment income. It is used to calculate the economic risk based capital by taking the difference of a VaR and the average.
3. CoG: The cost of guarantee is very low in this example because the soft guarantee level is low (3%) and the average investment return assumption is higher. Even with some periods of low investment return, the loss will be recovered with higher investment return in the long term.

4. IRR: Internal rate of return on distributable earnings.

5. TEV: The cost of capital is assumed to be 14% x Regulatory Capital Requirement.

6. Mortality shock: A 10% increase of mortality rates is assumed in this stress scenario. The result is used to calculate the required capital for mortality risk.

7. Lapse shock: A 20% reduction of lapse rates is assumed in this stress scenario. The result is used to calculate the required capital for lapse risk.

Comparing the deterministic result and the average result using stochastic analysis, it is clear that the WP business is less valuable considering all possible scenarios. Both PM and IRR drop materially. Based on the stochastic analysis and stress testing results, the risk based capital can be calculated with the correlation assumptions.

Table 3. Risk Based Capital Calculation

<table>
<thead>
<tr>
<th>Risk</th>
<th>Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Risk</td>
<td>99.5% VaR – Average</td>
<td>2,391</td>
</tr>
<tr>
<td>Mortality Risk</td>
<td>Mortality Shock - Deterministic</td>
<td>36</td>
</tr>
<tr>
<td>Lapse Risk</td>
<td>Lapse Shock - Deterministic</td>
<td>135</td>
</tr>
<tr>
<td>Insurance Risk</td>
<td>Aggregation</td>
<td>146</td>
</tr>
<tr>
<td>Economic Risk and Insurance Risk</td>
<td>Aggregation</td>
<td>2,459</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>20% of Other Required Capital</td>
<td>492</td>
</tr>
<tr>
<td><strong>Total Risk Based Capital</strong></td>
<td>Aggregation</td>
<td>2,606</td>
</tr>
</tbody>
</table>

Compared to the regulatory capital requirement which is based on the low gross premium reserve, risk based capital can better reflect the risk and the capital requirement of WP products.

MCEV is expected to be much lower than the TEV because of (a) the cost of risk based capital (CRNHR) is much higher in MCEV than the cost of capital in TEV and (b) the benefit of higher expected investment return based on the specific asset allocation plan is not included in the MCEV as it assumes a risk free return when valuing the liability.

6. Conclusion

With-profit products are fully of uncertainties given the volatile and unexpected market conditions, dynamic policyholder behaviors and dynamic management actions. It is important to understand all possible scenarios, the way policyholders will react and what management actions to be taken to mitigate adverse impacts. Stochastic analysis with dynamic linkage among economic conditions, policyholders and business managers are helpful to assess the return and risk of with-profit products. This objective is difficult to achieve with deterministic analysis.

With stochastic analysis, the risk of with-profit products can be compared with the company’s risk appetite to make sure risk tolerance will not be exceeded. It can also help to determine appropriate product features, price and bonus setting strategy.

Stochastic analysis requires sophisticated knowledge, models and high computing capability. The result is also sensitive to model assumptions such as economic assumptions in economic scenario generation.
Stress testing is useful for testing the robustness of stochastic models and results.

7. References